

## LOW-POWER AND LOW-OFFSET-VOLTAGE DUAL C-MOS OPERATIONAL AMPLIFIER

### ■ GENERAL DESCRIPTION

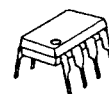
The NJU7094, 95 and 96 are dual C-MOS operational amplifiers operated on a single-power-supply, low voltage and low operating current.

The input offset voltage is lower than 2mV, and the input bias current is as low as than 1pA, consequently very small signal around the ground level can be amplified.

The minimum operating voltage is 1V and the output stage permits output signal to swing between both of the supply rails.

Furthermore, this series is packaged with a various small one therefore it can be especially applied to portable items.

### ■ PACKAGE OUTLINE



NJU709XD



NJU709XM



NJU709XV

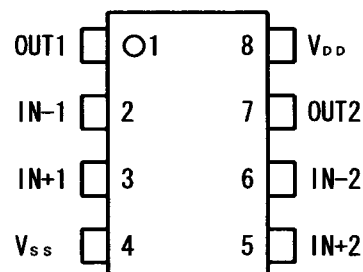


NJU709XR

### ■ FEATURES

- Single-Power-Supply
- Low Offset Voltage  $V_{IO}=2\text{mV max}$
- Wide Operating Voltage  $V_{DD}=1\sim 5.5\text{V}$
- Wide Output Swing Range  $V_{OM}=2.9\text{V min @}3.0\text{V}$
- Low Operating Current
- Low Bias Current  $I_{IB}=1\text{pA typ}$
- Compensation Capacitor Incorporated
- Package Outline DIP-8/DMP-8/SSOP-8/VSP-8
- C-MOS Technology

### ■ PIN CONFIGURATION

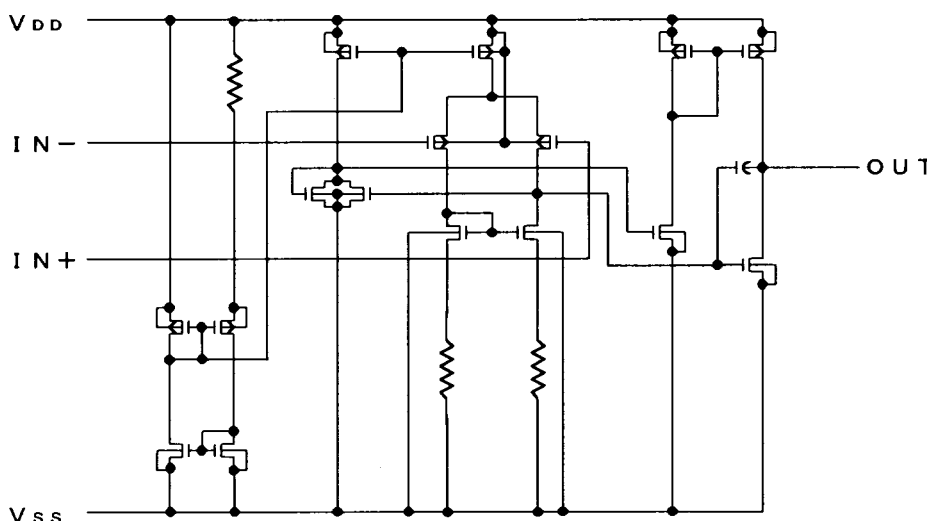


### ■ LINE-UP

( $T_a=25^\circ\text{C}$ ,  $V_{DD}=3.0\text{V}$ , Per Circuit)

| PARAMETER            | NJU7094 | NJU7095 | NJU7096 | UNIT                         |
|----------------------|---------|---------|---------|------------------------------|
| Operating Current    | 15      | 80      | 200     | $\mu\text{A}$ (typ)          |
| Slew Rate            | 0.1     | 1.0     | 2.4     | $\text{V}/\mu\text{s}$ (typ) |
| Unity Gain Bandwidth | 0.2     | 1.0     | 1.0     | $\text{MHz}$ (typ)           |

### ■ EQUIVALENT CIRCUIT



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

| PARAMETER                  | SYMBOL    | RATINGS                                                   | UNIT |
|----------------------------|-----------|-----------------------------------------------------------|------|
| Supply Voltage             | $V_{DD}$  | 7                                                         | V    |
| Differential Input Voltage | $V_{ID}$  | $\pm 7$ Note1                                             | V    |
| Common Mode Input Voltage  | $V_{IC}$  | - 0.3 ~ 7                                                 | V    |
| Power Dissipation          | $P_D$     | 500 (DIP-8)<br>300 (DMP-8)<br>250 (SSOP-8)<br>320 (VSP-8) | mW   |
| Operating Temperature      | $T_{opr}$ | - 40 ~ + 85                                               | °C   |
| Storage Temperature        | $T_{stg}$ | - 55 ~ +125                                               | °C   |

Note1) If the supply voltage ( $V_{DD}$ ) is less than 7V, the input voltage must not over the  $V_{DD}$  level though 7V is limit specified.

Note2) Decoupling capacitor should be connected between  $V_{DD}$  and  $V_{SS}$  due to the stabilized operation for the circuit.

## ■ ELECTRICAL CHARACTERISTICS

NJU7094

(Ta=25°C,  $V_{DD}=3.0V$ ,  $R_L=\infty$ )

| PARAMETER                       | SYMBOL    | CONDITIONS              | MIN          | TYP | MAX          | UNIT |
|---------------------------------|-----------|-------------------------|--------------|-----|--------------|------|
| Input Offset Voltage            | $V_{IO}$  | $V_{IN}=1/2V_{DD}$      | —            | —   | 2            | mV   |
| Input Offset Current            | $I_{IO}$  |                         | —            | 1   | —            | pA   |
| Input Bias Current              | $I_{IB}$  |                         | —            | 1   | —            | pA   |
| Input Impedance                 | $R_{IN}$  |                         | —            | 1   | —            | TΩ   |
| Large Signal Voltage Gain       | $A_{VD}$  |                         | 60           | 70  | —            | dB   |
| Input Common Mode Voltage Range | $V_{ICM}$ |                         | 0~2.5        | —   | —            | V    |
| Maximum Output Swing Voltage    | $V_{OM1}$ | $R_L=1M\Omega$          | $V_{DD}-0.1$ | —   | —            | V    |
|                                 | $V_{OM2}$ | $R_L=1M\Omega$          | —            | —   | $V_{SS}+0.1$ | V    |
| Common Mode Rejection Ratio     | CMR       | $V_{IN}=1/2V_{DD}$      | 55           | 65  | —            | dB   |
| Supply Voltage Rejection Ratio  | SVR       | $V_{DD}=1.5\sim 5.5V$   | 60           | 70  | —            | dB   |
| Operating Current               | $I_{DD}$  | Per Circuit             | —            | 15  | 25           | uA   |
| Slew Rate                       | SR        |                         | —            | 0.1 | —            | V/us |
| Unity Gain Bandwidth            | Ft        | $A_V=40dB$ , $C_L=10pF$ | —            | 0.2 | —            | MHz  |

Note3) The source current is less than 2.9uA (at  $V_{OM}/R_L=2.9V/1M\Omega$ ).

NJU7095

(Ta=25°C, V<sub>DD</sub>=3.0V, R<sub>L</sub>=∞)

| P A R A M E T E R               | SYMBOL           | CONDITIONS                                 | MIN                  | TYP | MAX                  | UNIT |
|---------------------------------|------------------|--------------------------------------------|----------------------|-----|----------------------|------|
| Input Offset Voltage            | V <sub>IO</sub>  | V <sub>IN</sub> =1/2V <sub>DD</sub>        | —                    | —   | 2                    | mV   |
| Input Offset Current            | I <sub>IO</sub>  |                                            | —                    | 1   | —                    | pA   |
| Input Bias Current              | I <sub>IB</sub>  |                                            | —                    | 1   | —                    | pA   |
| Input Impedance                 | R <sub>IN</sub>  |                                            | —                    | 1   | —                    | TΩ   |
| Large Signal Voltage Gain       | A <sub>VD</sub>  |                                            | 60                   | 70  | —                    | dB   |
| Input Common Mode Voltage Range | V <sub>ICM</sub> |                                            | 0~2.5                | —   | —                    | V    |
| Maximum Output Swing Voltage    | V <sub>OM1</sub> | R <sub>L</sub> =100kΩ                      | V <sub>DD</sub> -0.1 | —   | —                    | V    |
|                                 | V <sub>OM2</sub> | R <sub>L</sub> =100kΩ                      | —                    | —   | V <sub>SS</sub> +0.1 | V    |
| Common Mode Rejection Ratio     | CMR              | V <sub>IN</sub> =1/2V <sub>DD</sub>        | 55                   | 65  | —                    | dB   |
| Supply Voltage Rejection Ratio  | SVR              | V <sub>DD</sub> =1.5~5.5V                  | 60                   | 70  | —                    | dB   |
| Operating Current               | I <sub>DD</sub>  | Per Circuit                                | —                    | 80  | 160                  | μA   |
| Slew Rate                       | SR               |                                            | —                    | 1.0 | —                    | V/μs |
| Unity Gain Bandwidth            | F <sub>t</sub>   | A <sub>v</sub> =40dB, C <sub>L</sub> =10pF | —                    | 1.0 | —                    | MHz  |

Note4) The source current is less than 29μA (at V<sub>OM</sub>/R<sub>L</sub>=2.9V/100kΩ).

NJU7096

(Ta=25°C, V<sub>DD</sub>=3.0V, R<sub>L</sub>=∞)

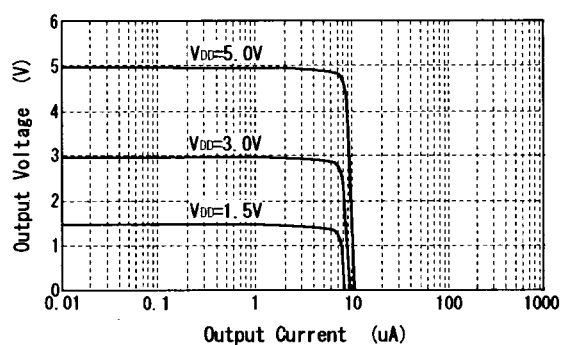
| P A R A M E T E R               | SYMBOL           | CONDITIONS                                 | MIN                  | TYP | MAX                  | UNIT |
|---------------------------------|------------------|--------------------------------------------|----------------------|-----|----------------------|------|
| Input Offset Voltage            | V <sub>IO</sub>  | V <sub>IN</sub> =1/2V <sub>DD</sub>        | —                    | —   | 2                    | mV   |
| Input Offset Current            | I <sub>IO</sub>  |                                            | —                    | 1   | —                    | pA   |
| Input Bias Current              | I <sub>IB</sub>  |                                            | —                    | 1   | —                    | pA   |
| Input Impedance                 | R <sub>IN</sub>  |                                            | —                    | 1   | —                    | TΩ   |
| Large Signal Voltage Gain       | A <sub>VD</sub>  |                                            | 60                   | 70  | —                    | dB   |
| Input Common Mode Voltage Range | V <sub>ICM</sub> |                                            | 0~2.5                | —   | —                    | V    |
| Maximum Output Swing Voltage    | V <sub>OM1</sub> | R <sub>L</sub> =50kΩ                       | V <sub>DD</sub> -0.1 | —   | —                    | V    |
|                                 | V <sub>OM2</sub> | R <sub>L</sub> =50kΩ                       | —                    | —   | V <sub>SS</sub> +0.1 | V    |
| Common Mode Rejection Ratio     | CMR              | V <sub>IN</sub> =1/2V <sub>DD</sub>        | 55                   | 65  | —                    | dB   |
| Supply Voltage Rejection Ratio  | SVR              | V <sub>DD</sub> =1.5~5.5V                  | 60                   | 70  | —                    | dB   |
| Operating Current               | I <sub>DD</sub>  | Per Circuit                                | —                    | 200 | 400                  | μA   |
| Slew Rate                       | SR               |                                            | —                    | 1.0 | —                    | V/μs |
| Unity Gain Bandwidth            | F <sub>t</sub>   | A <sub>v</sub> =40dB, C <sub>L</sub> =10pF | —                    | 1.0 | —                    | MHz  |

Note5) The source current is less than 58μA (at V<sub>OM</sub>/R<sub>L</sub>=2.9V/50kΩ).

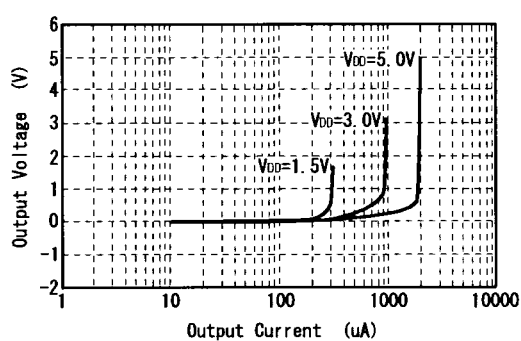
## ■ TYPICAL CHARACTERISTICS

## (1) NJU7094

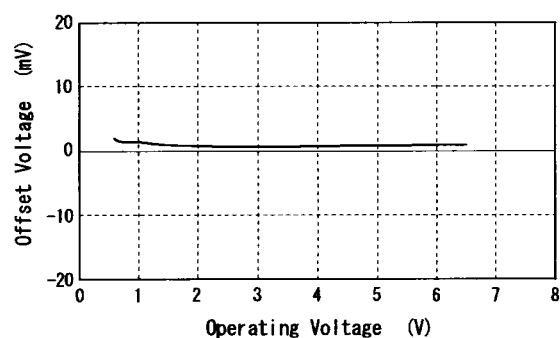
Output Voltage vs. Output Current (SOURCE)



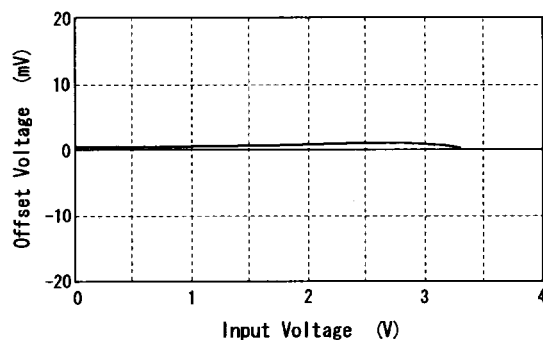
Output Voltage vs. Output Current (SINK)



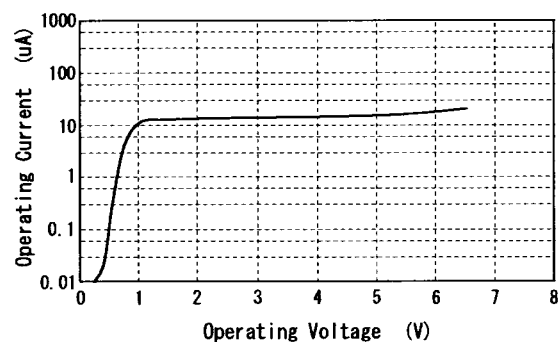
Offset Voltage vs. Operating Voltage

 $V_{IN}=0.1V$ 

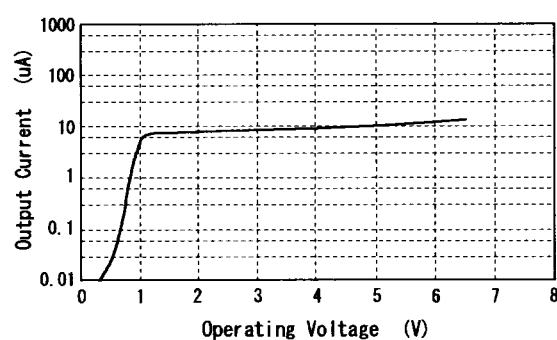
Offset Voltage vs. Input Voltage

 $V_{DD}=3.0V$ 

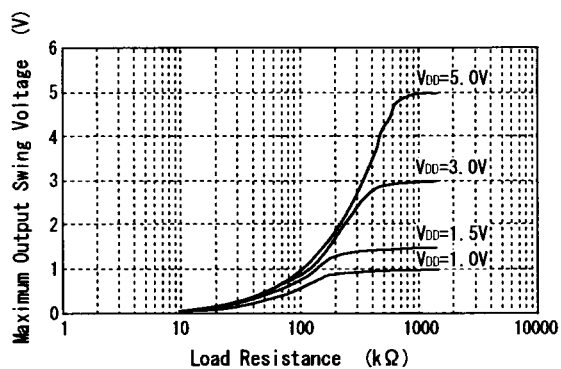
Operating Current vs. Operating Voltage

 $V_{IN}=0.1V$ 

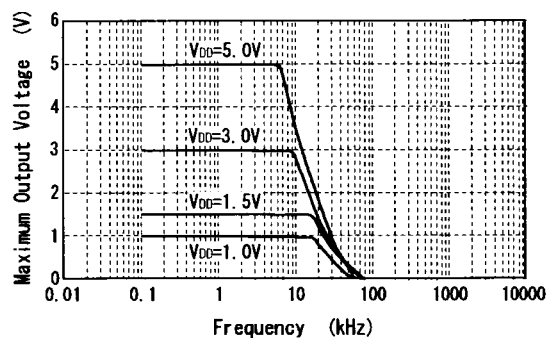
Output Current vs. Operating Voltage

 $V_{IN}=0.1V$ 

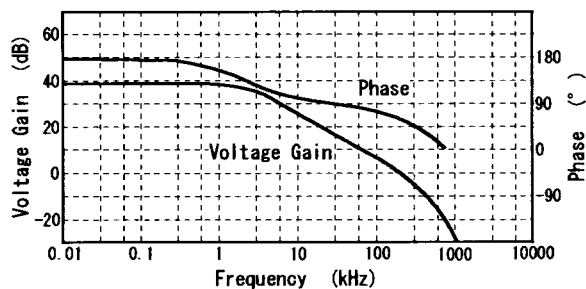
Maximum Output Swing Voltage vs. Load Resistance



Maximum Output Swing Voltage vs. Frequency

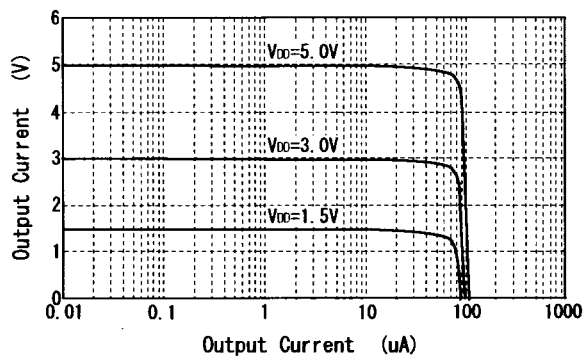


Voltage Gain-Phase vs. Frequency

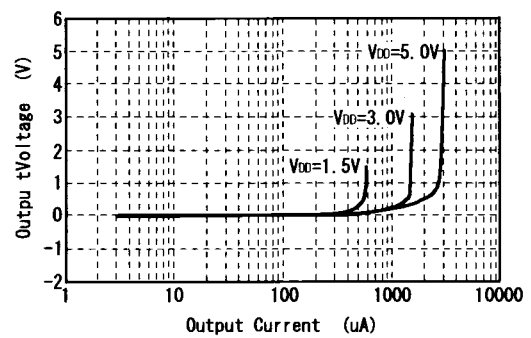
 $V_{DD}=3V$ ,  $R_S=1k\Omega$ ,  $A_v=40dB$ 

## (2) NJU7095

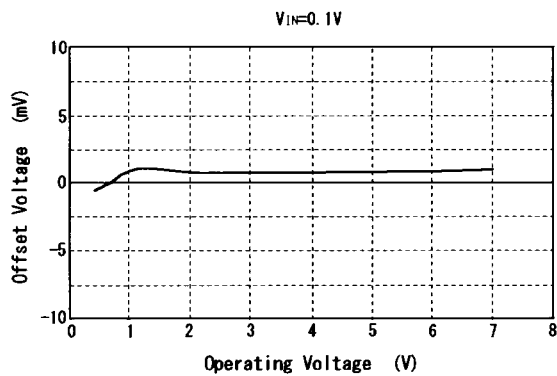
Output Voltage vs. Output Current (SOURCE)



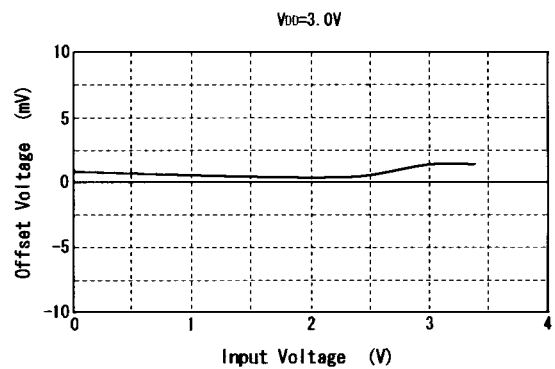
Output Voltage vs. Output Current (SINK)



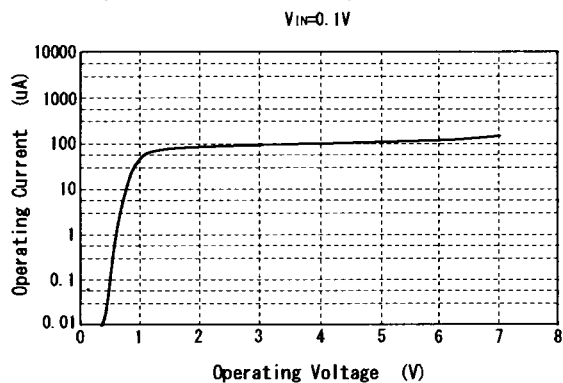
Offset Voltage vs. Operating Voltage



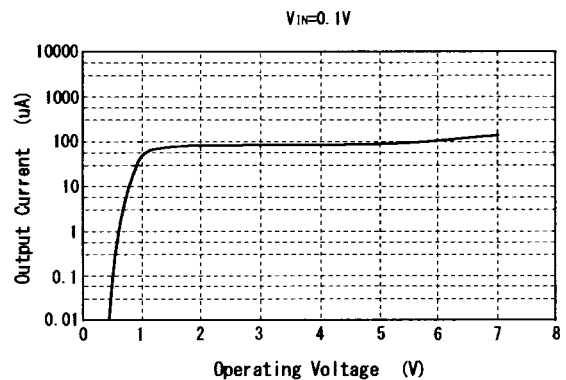
Offset Voltage vs. Input Voltage



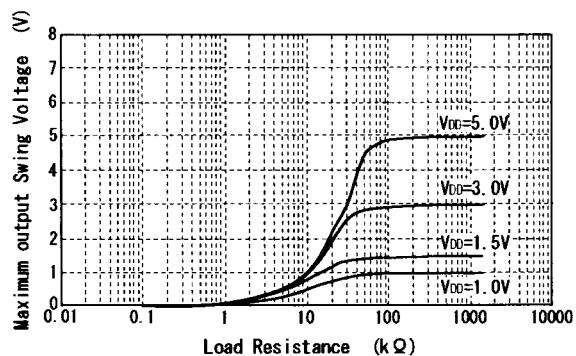
Operating Current vs. Operating Voltage



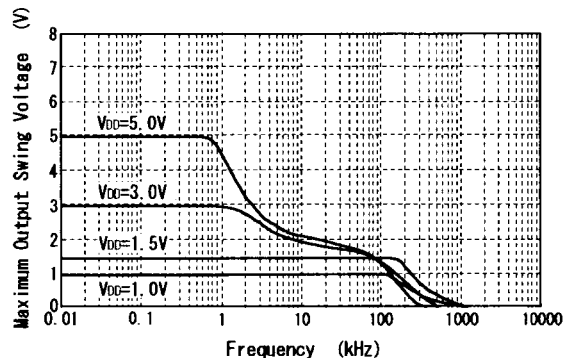
Output Current vs. Operating Voltage



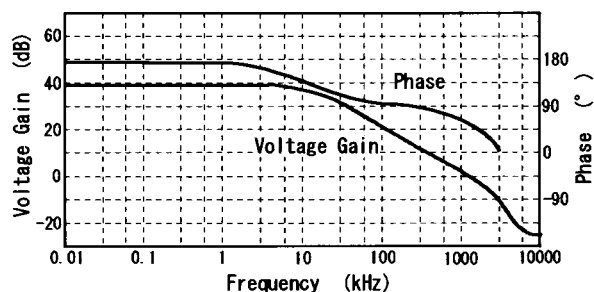
Maximum Output Swing Voltage vs. Load Resistance



Maximum Output Swing Voltage vs. Frequency

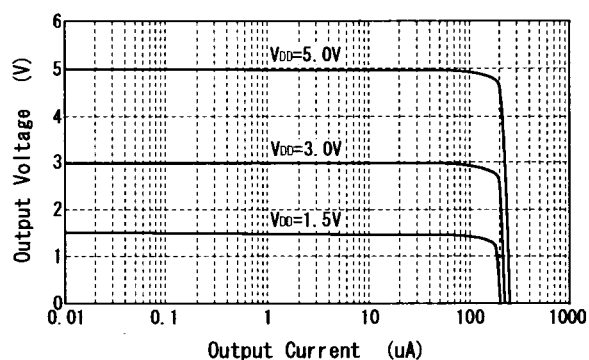


Voltage Gain-Phase vs. Frequency

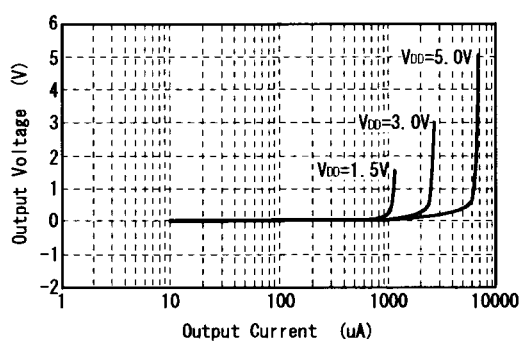
V<sub>DD</sub>=3V, R<sub>S</sub>=1kΩ, A<sub>v</sub>=40dB

## (3) NJU7096

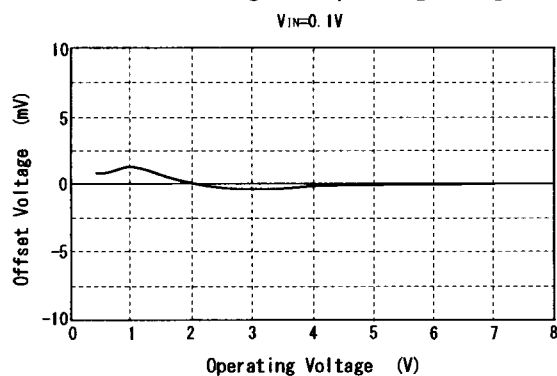
Output Voltage vs. Output Current (SOURCE)



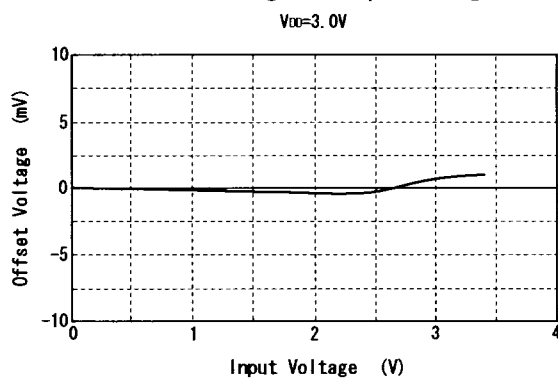
Output Voltage vs. Output Current (SINK)



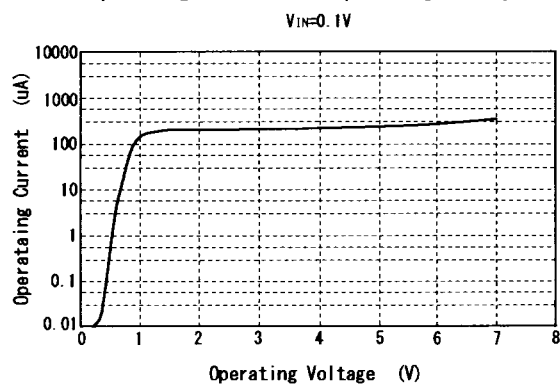
Offset Voltage vs. Operating Voltage



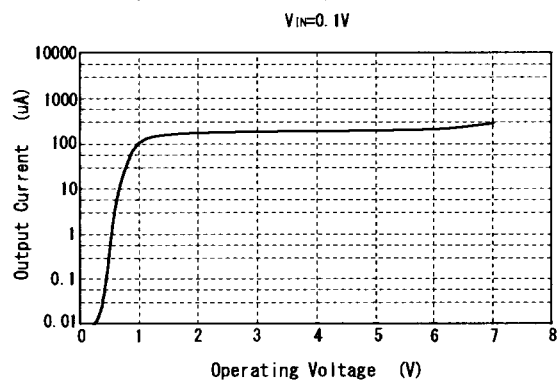
Offset Voltage vs. Input Voltage



Operating Current vs. Operating Voltage

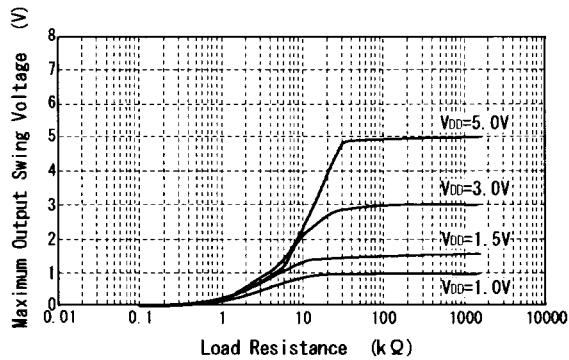


Output Current vs. Operating Voltage

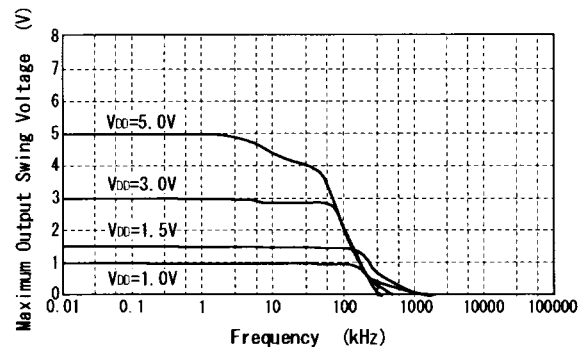




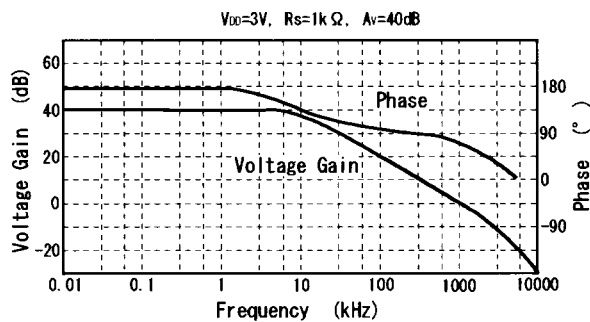
Maximum Output Swing Voltage vs. Load Resistance



Maximum Output Swing Voltage vs. Frequency



Voltage Gain-Phase vs. Frequency



## [CAUTION]

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